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# LACTIC FERMENTATION IN TRADITIONAL FOODS OF THAILAND*

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## I. BACKGROUND

Thailand, being a tropical agricultural country, has a wide variety of fermentation,ranging from traditional, cottage-level production of fermented foods and feeds to large-scale industrial production for export.

Lactic fermentations in Thailand play a significant role in the country's economy and employment, and the nutrition of its people. With a few exceptions of imported technologies, most lactic fermentations are based on local, indigenous technologies. While many production processes remain traditional, some have evolved from traditional to modern, advanced processing.

Major agricultural raw materials which are readily available for lactic fermentation include fish, meat, vegetables, fruits and cereals. Most lactic fermentations involve the use of salt with or without carbohydrate sources such as starch and sugar. Unlike mold and yeast fermentation, lactic fermentations rely on natural microorganisms instead of starter cultures.

Thailand is the location of a Microbiological Resource Center for SE Asia,known as Bangkok MIRCEN,where useful microbial cultures including lactic bacteria,are maintained. Several lactic bacteria strains having special characteristics such as salt and alcohol tolerance are available for future research use in genetic improvement.

## II. INTRODUCTION

Thailand, like most of the developing countries in Asia, is a country where several traditional fermentad food products are known for many decades. Many kinds of microorganisms are, of course, involved in such fermentation,including lactic fermentation.

The Thai traditional fermented foods are important elements in the diets of the majority of the people in Thailand, particularly in the rural areas of the country. These traditional fermented foods play a significant role in :

- o preserving easily perishable food, such as fruits, vegetables, meat and fish.
- o nutritional improving through the development of higher nutritional value and higher digestible products, e.g. yoghurt and yakult.

- o product development and diversification by means of new product development for better texture, flavor, and aroma.
- o sanitary quality improvement because fermentation accompanying by salt and acid will destroy pathogenic flora and other food-borne diseases normally caused by microorganisms.

Since Thailand is a developing country, most of the population have very low income, and therefore, food fermentation in the country has always been by traditional methods in small-scale and thus becomes family business. This is because it requires low investment and easier to manage than the larger scale. These fermented food products will be a good source of their additional income as well as their extra food supply.

## III. PRODUCTION OF MAJOR AGRICULTURAL PRODUCTS IN THAILAND

Being an agricultural country, the country economy depends largely upon agriculture. In 1980, more than 70% of the Thai population were engaged in agricultural production. Thailand has many kinds of raw materials available, the surplus of which is readily preserved through various means including traditional food fermentation. The major agricultural products are shown in Table 1.

Table 1 : Production of major agricultural products in Thailand, 1982/83

| Products | Quantity, tons | Value, million Bahts (25 Bahts = US $1) | |
|---|---|---|---|
| Rice: | | | |
| Rice | 16,879,000 | 4,742,230.0 | |
| Food crops: | | | |
| Maize | 3,002,300 | 6,034.6 | |
| Cassave roots, fresh | 17,788,000 | 9,071.8 | |
| Sugarcane | 24,407,000 | 11,398.3 | |
| Mungbean | 281,300 | 1,659.4 | |
| Oil Seeds: | | | |
| Soybean | 113,400 | 688.3 | |
| coconut | 1,076,000 | 1,998.8 | |
| | | 2,143.3 | |
| Other crops: | | | |
| Garlic | 173,400 | 2,608.1 | |
| Onion & shallot | 241,900 | 1,642.5 | |
| Chilli | 61,400 | | |
| Livestocks: | | | |
| Swines | 4,022,106 heads (3,252,504 slaughtered) | | (23.51 ฿/kg) |
| Cattles | 4,578,699 heads (356,683 slaughtered) | | (39.49 ฿/kg) |
| Buffaloes | 6,417,433 heads (86,506 slaughtered) | | (32.19 ฿/kg) |
| Fish: | | | |
| Fish (fresh water and marine) | 1,920,000 tons | 15,650.6 | |
| Bamboo shoots, fresh | 235 tons * | 2,279,000 * | bahts |
| Ginger, | 7,309 tons * | 68,674,000 * | " |
| Vegetables, dried, salted | 310 tons * | 7,408,000 * | " |
| Fruits, brining | 29 tons * | 593,000 * | " |
| Crustaceans and molluscs, salted | 193 tons * | 8,146,000 * | " |
| Blachan (Shrimp paste) | 106 tons * | 4,396,000 * | " |
| Fish sauce | 7,534 tons * | 112,038,000 * | " |
| Soya sauce | 214 tons * | 5,546,000 * | " |

* Quantity and value for export only

## IV. RAW MATERIALS AND PRODUCTS OF LACTIC FERMENTATIONS

The food fermentation industry in Thailand has been benefited by the use of lactic fermentation which contributes its important role in food preservation, food product development and nutrition improvement. Major raw materials for lactic fermentation and products are shown in Table 2.

Table 2: Major raw materials for lactic fermentation and its products.

| | Raw materials | | Scale of operation | Product | Consumption |
|---|---|---|---|---|---|
| I | Vegetables | : mixed vegetables. | Traditional & commercial | Si-sek-Chai | Local&export |
| | | turnips | " | Hua-chai-po | " |
| | | onion | " | Hom-dong | " |
| | | mushroom | " | Hed-dong | " |
| | | fermented tea leaves | Traditional | Sai-miang | Local |
| II | Fruits | : mango | Traditional & commercial | Phonlamai-dong | Local & export |
| | | papaya | " | mala-gor-dong | " |
| | | lime | " | ma-nao-dong | " |
| III | Fish | : fresh water | Traditional & and commercial | Nam-pla | Local & export |
| | | marine fish | " | pla-ra | " |
| | | | | pla-chao | Local |
| | | etc. | " | Som-fak | " |
| IV | Meat | : pork | Traditional & commercial | Naem | Local |
| | | pork or beef | " | Mu-som | " |
| | | | | Sai-krok prio | " |
| V | Cereals and Grains | : Rice | Traditional | Khanom-Chin | Local |
| | | | " | Khanom-tan | " |
| VI | Milk | : Milk | Commercial | Yoghurt | Local |
| | | | | Yakult | " |

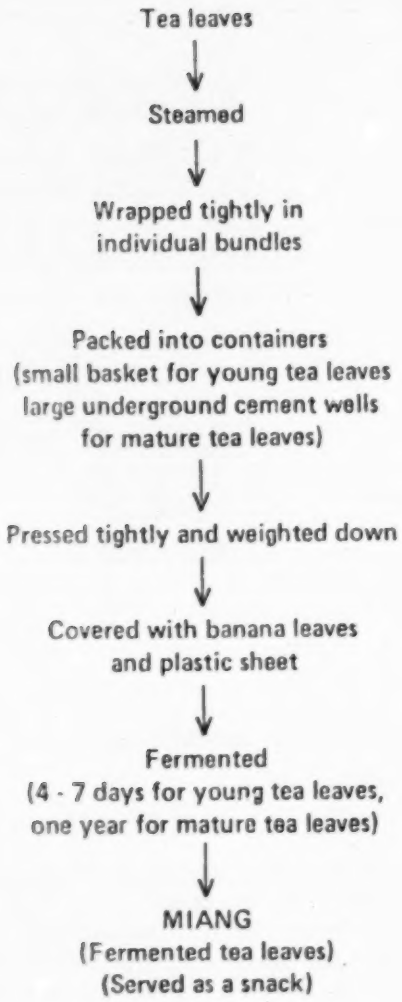
Different varieties of fermented products are products using essentially the same process. Variations are due to difference in raw materials and additives used. Some of the lactic acid bacteria involved are shown in Table 3.

Table 3: Major Lactic acid Becteria in Some Fermented Foods.

| Products | Raw material | Major Lactic Acid Bacteria |
|---|---|---|
| Soy sauce | Soybeans | Lactobacillus delbruckii<br>Pediococcus halophilus |
| Pickled fruits | Fruits | L.plantarum, L.brevis, P. cerevisiae,<br>Leuconostoc mesenteroides |
| Pickled vegetables | Vegetables | L.plantarum, L.brevis, S.lactis,<br>Pediococcus cerevisiae |
| Shrimp paste (Blachan) | Shrimp | L.casei var. casei , P. halophilus |
| Meat (Nham) | Pork | L.brevis, L.plantarum,<br>P.cerevisiae, Pediococcus sp. |
| Fermented bamboo | Bamboo shoot | L.brevis, L.buchneri, L.fermenti,<br>Leuconostoc mesenteroides<br>P.cerevisiae |
| Hoi-dong | Crustaceans | P.halophilus |
| Pla-som | Fish | P.pentosaseus |

## V. LACTIC FERMENTATION PROCESSES AND RESPONSIBLE MICROORGANISMS

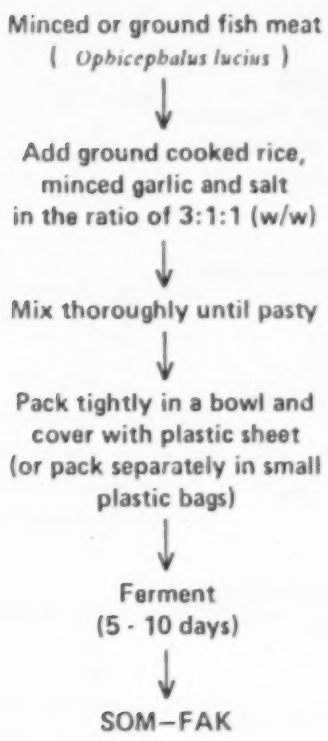
Most fermented foods in Thailand are generally produced through the methods of brining, marinating, sugaring, and fermenting or the combinations of these methods,i.e.,salted-fermented foods, etc. These means of fermentation are simple and most convenient for the household and therefore most of these products are prepared by cottage-type operations. Some of the lactic acid fermentation processes and responsible microorganisms are shown in the following diagrams :


Tea leaves
Steamed
Wrapped tightly in individual bundles
Packed into containers (small basket for young tea leaves large underground cement wells for mature tea leaves)
Pressed tightly and weighted down
Covered with banana leaves and plastic sheet
Fermented (4 - 7 days for young tea leaves, one year for mature tea leaves)
MIANG (Fermented tea leaves) (Served as a snack)

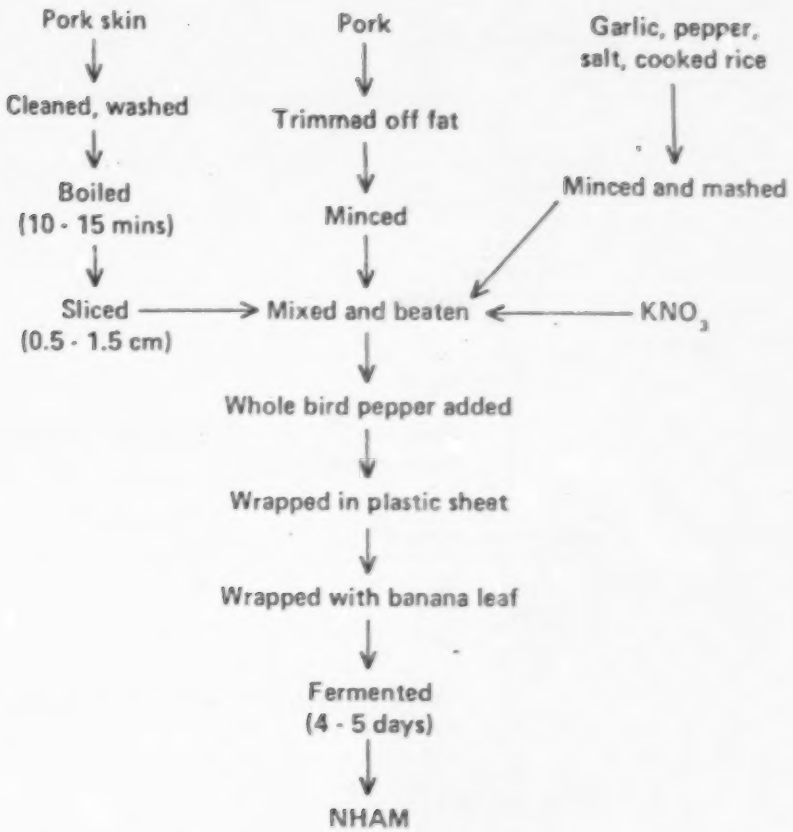
Flow sheet for the production of Miang.

Fresh water fish
( Trichogaster trichopterus, Notopterus notopterus, Opbicephalus striatus, Clarias batrachus )
Scale and remove the entrails
Mix with salt in the ratio of 3:1 (w/w)
Leave overnight
Pack tightly in small necked earthen jars
Cover with bamboo sticks and flood with saturated brine
Incubate (15 - 90 days)
Remove the fish from the jar and mix with ground roasted rice in the ratio of 1:10 (w/w)
Repack in the jar and flood with brine
Incubate for at least 6 months
PLA–RA

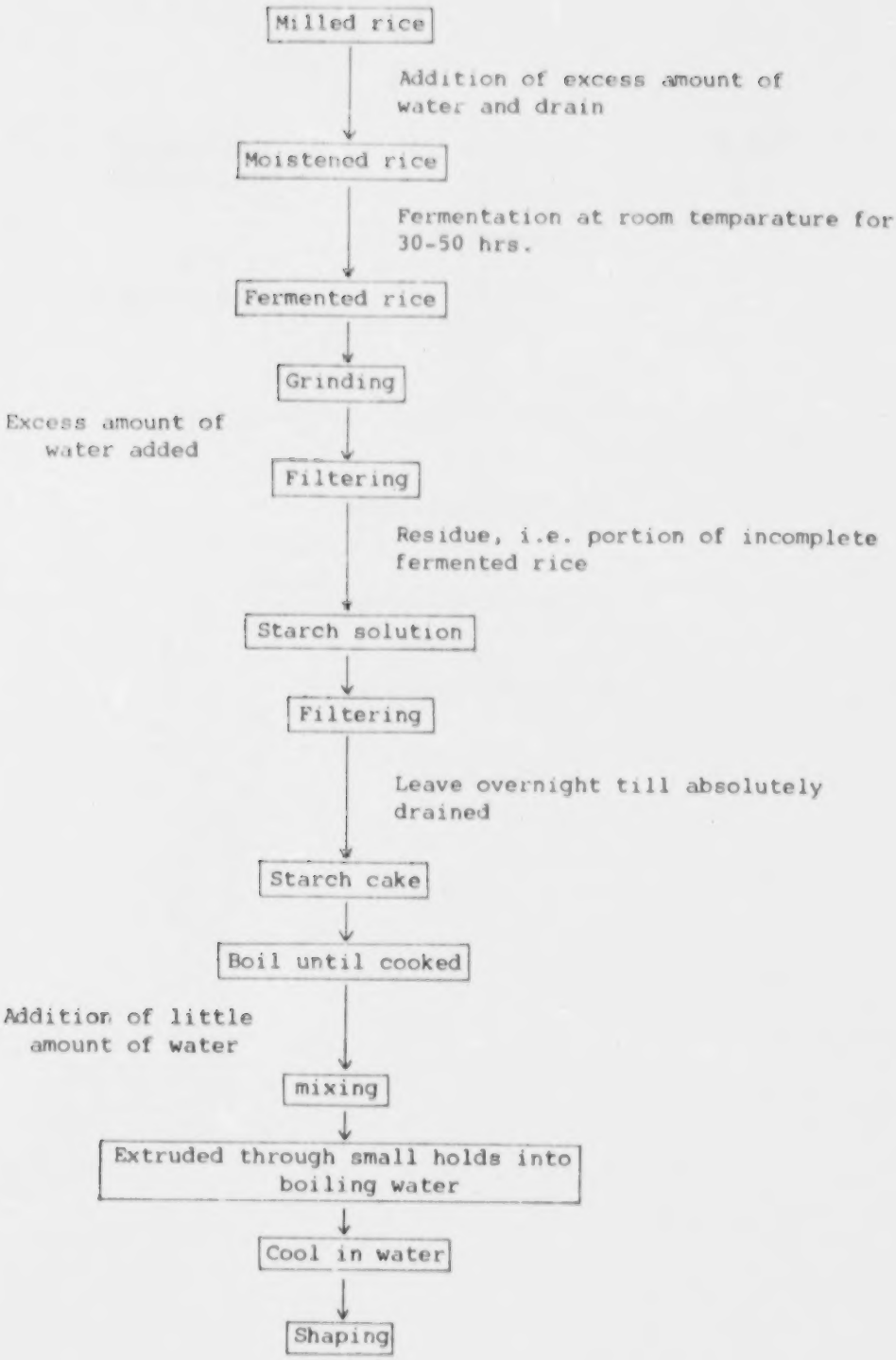
Flow sheet for the production of Pla-Ra.




Flow sheet for the production of Som-Fak




Flow sheet for Nham fermantation




The Flowsheet for the Production of Khanom-Chin from long-grain rice (Oryza sativa L.)

## VI. COMMERCIALIZATION OF TRADITIONAL LACTIC FERMENTATIONS

The fermentation of these traditional fermented foods vary from the simplest to the most complex process but research and devclopment of food fermentation in Thailand has been limited. In many cases, the microbial starter is carried over from fermentation to fermentation and in no case that the pure culture is used. However, at present, fermentation technology has been playing a very important part in the food industry and it has taken quite progressive steps into many kinds of commercial food production. Some traditional fermented foods at cottage-level becomes popular amongst consumers and the larger scale production has been developed. There are many factories nowadays which produce fermented products such as Nam-pla and Nham. These products are being exported.

In fact, there are certainly some advantages for the commercial scale food fermentation. The products will be of improved quality and higher nutrition value through modernized technology of production. However, there are also some disadvantages as to the higher cost of production due to expensive equipment and then less workers are required causing some social problems in the country.

According to recent survey, in 1984, the commercial fermentations in Thailand which are classified into 13 types, as shown in Table 4, are quite large in number.

Table 4: Numbers and types of fermented food factories.

| Products | Number of factories |
|---|---|
| Glucose | 18 |
| Vinegar | 9 |
| Alcoholic beverages | 35 |
| Soy sauce and related products | 35 |
| Yoghurt and related products | 4 |
| Citric acid | 1 |
| Food flavoring agents | 5 |
| Yeast | 1 |
| Antibiotics | 1 |
| Nham | 9 |
| Fermented fruits and vegetables | 24 |
| Nam-pla | 36 |

## VII. BANGKOK MIRCEN AND TECHNICAL COOPERATION

MIRCENS are a world network of microbiological resource centers each emphasizing specific areas of interest, with the Bangkok MIRCEN serving in the area of fermentation, food and waste recycling. Established within the framework of UNEP/UNESCO quidelines, MIRCENS are designed :

- o to promote the applications of microbiology in the strengthening of rural economics.
- o to serve as focal centers for the training of manpower and the imparting of microbiological knowledge, and
- o to provide the infrastructure for the building of a world network which would incorporate regional and interregional cooperating laboratories geared to the management, distribution, and utilization of the microbial gene pool.

Bangkok MIRCEN maintains a small collection of lactic acid bacteria known to be responsible for several lactic fermentations. The name list of such collection is given in Annex I. Bangkok MIRCEN could serve as a focal center for lactic fermentation training as well as a focal point for interregional cooperating laboratories wishing to exchange microbial cultures and related technical information.

Bangkok MIRCEN operates in cooperation with its affiliated laboratories in the Southeast Asian Region, namely :

- o Natural Science Research Center, University of the Philippines, Philippines.
- o Faculty of Mathematics and Natural Sciences, University of Indonesia, Indonesia.
- o Department of Botany, National University of Singapore, Singapore.
- o Microbiology Department, National University of Malaysia, Selangor, Malaysia.
- o Department of Biology, Chinese University of Hong Kong, Hong Kong.
- o Soil Microbiology Branch, Division of Soil Science, Department of Agriculture, Bangkhen, Bangkok, Thailand.
- o Department of Microbiology, Kasetsart University, Bangkhen, Bangkok, Thailand

ANNEX I

LIST OF LACTIC ACID BACTERIA

TISTR Culture Collection

Bangkok MIRCEN

1984

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| | | |
|---|---|---|
| *Lactobacillus* | *acidophilus* (Moro) | Hansen & Mocquot |
| 382 | TUA 002 | 1980 |
| 450 | TUA 346 L | 1981 |
| *Lactobacillus* | *buchneri* (Henneberg) | Bergey et. al. |
| 48 | DMKU---ATCC 4005 | 1970 (5,10) |
| *Lactobacillus* | *bulgaricus* (Orla-Jensen) | Rogosa & Hansen |
| 451 | TUA 093 L | 1981 |
| *Lactobacillus* | *casei* (Orla-Jensen) | Hansen & Lessel |
| 47 | DMKU---ATCC 7469 | 1970 |
| 372 | TUA 333---ATCC 7469 | 1979 |
| 389 | TUA 016 | 1980 |
| 390 | TISTR | 1980 (4) |
| 453 | TUA 164 L | 1981 |
| 477 | MSDS--- ATCC 7469 | 1983 |
| *Lactobacillus* | *cellobiosus* | |
| 348 | TISTR | 1980 (4) |
| *Lactobacillus* | *delbrueckii* (Leichmann) | Beijerinck |
| 108 | NRRL B-445 | 1976 |
| 326 | UPCC 77 | 1977 |
| *Lactobacillus* | *fermentum* Beijerinck | |
| 55 | DMKU---ATCC 14931 | 1970 (5,10) |
| 391 | TISTR | 1980 (4) |
| *Lactobacillus* | *lactis* (Orla-Jensen) | Bergey et. al. |
| 452 | TUA 026 L | 1981 |
| *Lactobacillus* | *Leichmanii* (Henneberg) | Bergey et. al. |
| 449 | UQM 1364 | 1981 |
| 476 | MSDS---ATCC 7830 | 1983 |

| | | |
|---|---|---|
| *Lactobacillus* | *plantarum* (Orla-Jensen) | Bergey et. al. |
| 50 | DMKU---ATCC 8041 | 1970 (5,10) |
| 373 | TUA 354---ATCC 8041 | 1979 |
| 475 | MSDS---ATCC 8014 | 1983 |
| *Lactobacillus* | *vaccine* | |
| 460 | TUA X90 | 1981 |
| *Leuconostoc* | *citrovorum* | |
| 455 | TUA 165 L | 1981 |
| *Leuconostoc* | *dextranicum* (Beijerinck) | Hucker and Pederson |
| 56 | DMKU---ATCC 19255 | 1970 (5,10) |
| 377 | TUA 204 (P-S)---IFO 3349 | 1979 |
| 454 | TUA 204 L | 1981 |
| 474 | DMKU 8M8/25 B | 1982 |
| *Leuconostoc* | *mesenteroides* (Cienkowski) | van Tieghem |
| 53 | DMKU---ATCC 10830 | 1970 (5,10) |
| 120 | UPCC 44 | 1976 |
| 473 | DMKU 8M8/25 A | 1982 |
| 478 | MSDS---ATCC 8042 | 1983 |
| *Pediococcus* | *acidilactici* Lindner | |
| 397 | NISL 7113 | 1980 |
| 424 | DMKU N53 | 1981 (14,15) |
| 425 | DMKU N54 | 1981 (14,15) |
| *Pediococcus* | *acidophilus* | |
| 375 | IFO 3205---AHU 1123 | 1979 |
| *Pediococcus* | *cerevisiae* Balcke | |
| 51 | DMKU---ATCC 8042 | 1970 |
| 335 | UQM 786 | 1977 |

*Pediococcus* *halophilus* Mees

| | | |
|---|---|---|
| 332 | DMKU B119 | 1977 (11) |
| 333 | DMKU B120 | 1977 (11) |
| 334 | DMKU B121 | 1977 (11) |
| 429 | DMKU Ph01 | 1981 (6,14,15) |
| 430 | DMKU Ph25 | 1981 (6,14,15) |
| 431 | DMKU Ph27 | 1981 (14,15,16) |
| 432 | DMKU Ph45 | 1981 (14,15) |
| 433 | DMKU Ph47 | 1981 (3,14,15) |
| 434 | DMKU Ph59 | 1981 (3,14,15) |
| 435 | DMKU Ph65 | 1981 (14,15,16) |
| 436 | DMKU Ph88 | 1981 (1,14,15) |
| 437 | DMKU Ph120 | 1981 (9,14,15) |
| 438 | DMKU Ph130 | 1981 (9,14,15) |
| 439 | DMKU Ph155 | 1981 (14,15,16) |

*Pediococcus* *pentosaseus* Mees

| | | |
|---|---|---|
| 374 | TUA P-19---IFO 3891 | 1979 |
| 413 | DMKU N01 | 1981 (14,15) |
| 414 | DMKU N31 | 1981 (14,15,16) |
| 415 | DMKU N37 | 1981 (14,15) |
| 416 | DMKU N38 | 1981 (14,15) |
| 417 | DMKU N78 | 1981 (14,15) |
| 418 | DMKU N91 | 1981 (14,15) |
| 419 | DMKU N133 | 1981 (14,15) |
| 420 | DMKU N256 | 1981 (14,15) |
| 421 | DMKU N271 | 1981 (14,15,16) |
| 422 | DMKU N278 | 1981 (14,15) |
| 423 | DMKU N295 | 1981 (14,15,16) |

*Pediococcus* sp:

| | | |
|---|---|---|
| 129 | TISTR | 1977 |

*Pediococcus* *soyae* Sakaguchi

| | | |
|---|---|---|
| 72 | IAM 1688---ATCC 13624<br>---NISL NO. 7153 | 1972 |

*Pediococcus* *urine-equi*

| | | |
|---|---|---|
| 394 | IAM 1684 | 1980 |
| 426 | DMKU N86 | 1981 (14,15) |
| 427 | DMKU N01 | 1981 (14,15) |

*Streptococcus* *cremoris* Orla-Jensen

| | | |
|---|---|---|
| 58 | TISTR | 1970 |
| 456 | TUA 439L | 1981 |

| | | |
|---|---|---|
| *Streptococcus* | *faecalis* Andrewes and Horder | |
| 379 | TUA 369---ATCC 19433 | 1979 |
| 459 | TUA 194L | 1981 |
| *Streptococcus* | *lactis* (Lister) Lohnis | |
| 457 | TUA 154L | 1981 |
| *Streptococcus* | *lique* | |
| 378 | TUA 156 (4-15) | 1979 |
| *Streptococcus* | *thermophilus* Orla-Jensen | |
| 59 | TISTR | 1970 |
| 458 | TUA 196L | 1981 |

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